Gd Eu Tb Sm Dy Pm Ho RARVS Nd Er Pr Tm Ce Yb La Sc Y Lu

Rare-earth Information Center Insight

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Volume 12 | June 1, 1999 | No. 6

Motor Sports

A hybrid car powered by a six liter Ford V8 and a 100 kW brushless DC motor from Zytek Systems Ltd. ran in the 1998 Petit Le Mans race at the Road Atlanta Raceway in Georgia (USA). While the report {*R&D*, **41**, [5], 75 (1999)} does not give specifics, the car had a battery pack consisting of 260 1.2V NiMH cells.

More Scandium in Aluminum

Microalloying additions of Sc, Ni, and Ce in an Al-Zn-Mg-Cu alloy have been studied by Yu-Lei Wu et al. {*Metall. Trans A*, **30** 1017-24 (1999)}. The alloy, a recently developed Chinese super-high-strength alloy C912 for aeronautical applications, has tensile and compressive strength similar to the new Alcoa alloy 7055 and the Russian alloy B96, which are the highest strength commercial IM/Al-Zn-Mg-Cu alloys. These alloys are traditional ingot-based alloys as opposed to powder metallurgy and higher cost Al-Li alloys. The problem, with most high-strength aluminum alloys, is that they are prone to stress corrosion cracking. A major goal of the reported research was to determine if Sc is effective in retarding recrystallization, thus, refining the microstructure, improving strength and corrosion resistance. As in other Al alloys, the Sc forms $Al_3(Sc,Zr)$ coherent precipitates, which were found to be highly effective in refining the grain structure in the wrought Al-Zn-Mg-Cu alloys, producing the highest strength and corrosion resistance of the alloys studied.

Gd_2O_3 Insulating Layers for Gallium Arsenide

III-V compound semiconductors, the III and V referring to the group in the periodic table, were once viewed as the future of semiconductor electronics because of their favorable intrinsic properties. Gallium arsenide, GaAs, was considered the leading candidate to replace Si in electronics. One difficulty that has prevented this from happening is the relative difficulty of growing the insulating layers necessary for device fabrication. As modern semiconductor technology has a multilayer structure, the insulating layer must be epitaxial with the GaAs. Recently, M. Hong et al. {*Science,* **283** 1897-900 (1999)} have demonstrated that Gd_2O_3 can be grown in the (110) orientation on a (100) GaAs surface. The key is that the spacing for three Gd_2O_3 [001] lattices measures 32.4 Å, while four GaAs [001] lattices are 32 Å. Needless to say, the epitaxy must be complex. The leakage currents for the Gd_2O_3 layers are extremely low in the 10^{-9} to10^{-10} A/cm^2 region at zero bias. The authors have fabricated a GaAs MOSFET using the Gd_2O_3-GaAs structures.

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Thin Film Phosphors

For thin film electroluminescent (TFEL) display applications, a blue phosphor is required. There has been extensive work on SrS:Ce^{3+} films, but the luminescence of these films is bluish-green, which has limited commercial application. The luminescence properties can be improved by codoping with Mn, Cl or Ag in order to compensate for the charge mismatch between the Ce^{3+} and the II-V host. Commercial TFEL displays are fabricated by atomic layer epitaxy (ALE), but the lack of a suitable volatile Ag precursor has prevented the production of Ag doped SrS:Ce films by this method. An alternative approach to the direct ALE fabrication of the codoped film is to produce the SrS:Ce^{3+} films by ALE and then ion implant the Ag. Wei-Min Li et al. {*Appl. Phys. Lett.*, 74 2298-300 (1999)} have demonstrated that Ag codoping of ALE films, which are subsequently annealed at 800°C, results in both an improvement in the chromaticity and luminescence. The luminescence is improved by a factor of two over the un-codoped films. At the current time, the Ag implantation depth is insufficient for commercial TFEL devices, but presumably higher implantation energies can improve the depth profile.

Stress Analysis by Mechanoluminescence

The stress distribution in a load bearing part determines the lifetime of the part because of its importance in crack initiation and growth. While it is relatively easy to measure stresses on surfaces, the mapping of the distribution throughout the part is very difficult. Chao-Nan Xu et al. {*Appl. Phys. Lett.,* 74, 2414-16 (1999)} have demonstrated a novel method of viewing the stress distribution in a solid using mechanoluminescence. Mechanoluminescence is observed in materials where a meta stable state may be populated by exposing the material to high intensity light of a sufficiently short-wave length. The incoming photons excite electrons into the conduction band, and these electrons are subsequently captured by shallow traps. When stress is applied, the trap depth is decreased, and the electron is free to decay to its original state emitting a photon. $SrAl_2O_4$:Eu turns out to have a large mechanoluminesence effect. Xu et al. produced shapes by mixing powders of this material with optical epoxy. Stressing the parts resulted in a luminescence mapping of the stress that agreed with model calculations. Naturally, the luminescence decreased with time as the traps were depleted, but UV light could be used to repopulate the traps.

Sr_2CeO_4 Blue Phosphors

In the April 99 *Insight*, I reported on a review article on combinatorial synthesis of materials, where large libraries of materials are produced using multiple targets and computer controlled masks to systematically cover larger ranges of chemical composition in an array of thin film dots. A recent paper {*Appl. Phys. Lett.,* 74 1677-79 (1999) demonstrates how a phosphor material identified by this means can then be fabricated by conventional wet chemical techniques for evaluation as a commercial phosphor. The phosphor is Sr_2CeO_4, which has a blue emission peak at ~470 nm. Precursors were formed by chemical coprecipitation and calcined at a variety of temperatures. The cathode luminescence of the new phosphor powders was measured, and the results are said to be better than the thin film samples. It is suggested that further enhancements may be obtained by codoping with an alkaline earth.

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